REMARKS

In the Office Action, the Examiner required a certified copy of the UK application under 35 U.S.C. 119(b). However, it is not believed that a certified copy of the UK application is required since this application is a national phase application (35 USC 371). However, if the Examiner believes that a certified copy is necessary under 35 USC § 119(b)(3), to properly claim priority to the foreign application in this case, the Examiner is respectfully invited to telephone the undersigned who shall then attempt to procure one, as applicable, during the pendency of the application.

With respect to the drawings, the legend –Prior Art—has been inserted as directed above and the duplicative use of reference numeral 63 has also been eliminated by the filing of the foregoing amendments to the drawings.

With respect to the specification, appropriate section headers have been added to comply with U.S. formalities. Also, other sections of the specification have been amended to make the use of reference numerals 61, 62 and 63 consistent as between the amended drawings and the substitute specification.

The claims, as amended herein, are fully supported by the application as originally filed. No new matter is believed to have been added.

Claim 1 is objected to as being awkwardly phrased.

Claim 1, 4, 5 are rejected under 35 U.S.C. § 112, second paragraph, as being indefinite.

Claims 12-13 are rejected under 35 U.S.C. § 102(b) as allegedly anticipated by admitted prior art WO98/16387.

Claims 1-3, 7-11 are rejected under 35 U.S.C. § 103(a) as allegedly obvious over Bourrieres et al. (WO 98/16387) in view of Mitter U.S. 4612874.

Claims 4-6 are rejected under 35 U.S.C. § 103(a) as allegedly obvious over Bourrieres et al. (WO 98/16387) in view of Mitter U.S. 4612874 and further in view of Ha et al. (U.S. 5824155).

The Examiner's objection and rejections are addressed in detail below. Reexamination, reconsideration, and allowance of the present application are respectfully requested in view of the foregoing amendments and the following remarks:

Claim Objections

As requested, claim 1, line 6 has been amended to read "...product in use is...". Applicant respectfully requests withdrawal of this ground for objection.

Rejections Under 35 U.S.C. § 112

Claim 1, 4, 5 are rejected under 35 U.S.C. § 112, second paragraph, as being indefinite.

Claim 1, line 3 has been amended to define that the wiper blades are "...attached to..." the main body. It is submitted that this recitation is clear within the meaning of 35 U.S.C. § 112.

Claim 1, line 8 defines that the second chamber is defined "...in part..." by the main body and the wiper blades. As illustrated in Figure 5, the second chamber (50) is defined by the main body (30), the wiper blades (31, 32) and the printing screen (34). As the printing screen (34) does not form part of the printing head, and thus is not being expressly claimed as a feature of the invention, it is submitted that the definition that the

second chamber (50) is defined in part by the main body (30) and the wiper blades (31, 32) is correct.

Claim 1, lines 10 to 14 has been amended to define that the flow director is such as "...to cause a first, circulatory flow of pasty product contained therein which passes over the surface of the printing screen, and a second flow of pasty product towards the printing screen which acts to force pasty product of the first, circulatory flow towards the printing screen and into apertures therein." This amendment is intended to more clearly emphasize that the flow director causes two flows of pasty product, the first flow being a circulatory flow which passes over the surface of the printing screen and the second flow being in a direction towards the printing screen and acting to intersect the first, circulatory flow to force pasty product of that circulatory flow towards the printing screen and into apertures therein. It is this generation and interaction of first and second flows of pasty product which is the principal feature of the present invention.

Claim 4, line 2 has been amended to define that the circulatory flow passes "...beneath lower edges of the vanes.", thereby obviating the objection as regards the lack of an antecedent.

It is believed that these amendments have obviated the Examiner's grounds for rejection under 35 U.S.C. § 112 and Applicant respectfully ask that they be withdrawn.

Rejections Under 35 U.S.C. § 102(b)

The Examiner is alleging that the subject matter of claims 12 and 13 is anticipated by the admitted prior art.

In response to this objection, claim 12 has been amended to define that the chamber includes a flow director in the same manner as claim 1.

As acknowledged by the Examiner, WO-98/16387 (Bourrieres *et al*), the admitted prior art, does not disclose or suggest a printing head which incorporates a flow director.

As is well settled, for a prior art reference to anticipate in terms of 35 U.S.C. § 102, every element of the claimed invention must be identically shown in a single reference and these elements must be arranged as in the claim under review. In re Bond. 910 F.2d 831, 15 USPQ2d 1566 (Fed. Cir. 1990).

With regards the admitted prior art, it is important to recognize that the drawings in the admitted prior art (particularly Figure 3) and the counterpart drawing (Figure 2) in this application are schematic drawings which illustrate the printing screen as a very thick structure relative to the printing head in order to demonstrate the operation of the printing head. In reality, the printing screen is a very thin structure, typically of the order 100 microns thick, relative to the main body, typically several centimeters high, and thus the volume of paste delivered to the apertures in the printing screen is only a very tiny fraction of the volume of paste contained in the main body of the printing head. Given that only a tiny volume of paste is delivered from the printing head in a printing operation, and the essentially static pressure applied by the drive piston, a flow of paste is not developed which intersects the circulatory flow. The Examiner, in considering Figure 2 of this application, is perhaps interpreting the vertical arrow as depicting an intersecting flow into an aperture in the printing screen. On reflection, it is recognized that Figure 2 could perhaps be misleading. The vertical arrow is merely intended to convey that paste is displaced from the circulatory flow into the aperture, and not the presence of an

intersecting flow. The printing head of the admitted prior art provides no such intersecting flow.

For at least the foregoing distinctions, Applicant respectfully requests the withdrawal of this ground for rejection.

Rejections Under 35 U.S.C. § 103(a)

The Examiner is alleging that the subject matter of claims 1 –3, 7-11, are unpatentable over the disclosures of Bourrieres *et al.* in view of US-4612874 (Mitter).

As the Examiner has acknowledged, Bourrieres *et al.* fails to disclose or suggest the provision of a flow director as required by the claimed invention.

In interpreting the disclosure of Bourrieres *et al.*, the Examiner apparently considers the chamber bounded by the piston (10) and the upper surface of the grille (17) to be the first chamber of the claimed invention, and the chamber bounded in part by the wiper blades (15) and the lower surface of the grille (17) to be the second chamber of the claimed invention.

The Examiner is apparently alleging that it would have been immediately apparent to a person skilled in the art to modify the printing head of Bourrieres *et al* to include a deflector of the kind as disclosed in Mitter in the second chamber beneath the grille (17).

In this regard, it is not understood how the Examiner proposes to modify the printing head of Bourrieres *et al* to accommodate a deflector as disclosed in Mitter.

In Mitter, the deflector, as exemplified as one or more shoulders (7a; 207a, 207a') or a rod which can be circular (107a; 1517), polygonal (517) or tear-shaped, is provided to prevent printing product from flowing along a straight or substantially straight path from a source into contact with a workpiece (see, for example, column 4, lines 62 to 66).

Given the construction of the printing head of Bourrieres *et al*, in which the grille (17) includes apertures across the full width thereof, it is not clear how a deflector of the kind as disclosed in Mitter could possibly be introduced beneath the grille (17) in such a manner as to prevent a direct flow path from the grille (17) to the printing screen (2).

This notwithstanding, Bourrieres *et al.* expressly teaches (see, for example, page 5, lines 6 to 20) that printing heads, such as disclosed in WO-96/20088, which are internally shaped and include components, notably baffle plates, in the outlet path, suffer from particular technological problems, notably the lamination of pastes.

It is respectfully submitted that it is inconceivable that a person skilled in the art would, where relying on the teaching of Bourrieres *et al.*, have contemplated modifying the printing head disclosed in Bourrieres *et al.* in a manner which is contrary to its very teaching.

In particular, Bourrieres *et al.* expressly teaches (see, for example, page 12, lines 8 to 11) that the cavity, which contains the printing product and includes the outlet at one, the lower, end thereof, essentially has rectilinear and/or parallel internal walls, that is, without any deflector, so as to avoid dissociation of components of the printing product.

This particular requirement of Bourrieres *et al.* could manifestly not be achieved by the provision of a deflector, whether as one or more shoulders or as a rod.

Indeed, it is submitted that to allege that a person skilled in the art would have been motivated to modify the printing head of Bourrieres *et al.* in a manner which was against its express teaching would manifestly require an impermissible hindsight analysis of the prior art.

Nevertheless, it is submitted that the claimed invention is clearly distinguished over the disclosures of Bourrieres *et al.* and Mitter when taken alone or in combination, in requiring the provision of a flow director which provides both a first, circulatory flow of pasty product over the surface of a printing screen, and a second flow of pasty product towards the printing screen which acts to force pasty product of the first, circulatory flow towards the printing screen.

It is acknowledged that the printing head of Bourrieres *et al.* provides for a circulatory flow of printing product, as indicated by the circulation arrows in Figure 13, but Bourrieres *et al.* does not provide a further flow which is such as to intersect the circulatory flow to force printing product of that circulatory flow towards the printing screen.

It is also acknowledged that Mitter discloses screen printing apparatus which include a deflector, as exemplified as one or more shoulders (7a; 207a, 207a') or a rod which can be circular (107a; 1517), polygonal (517) or tear-shaped, in the outlet, but that deflector does no more than the stated objective of preventing printing product from flowing along a straight or substantially straight path from a source into contact with a workpiece, that is, deflect a flow from its introduced direction of flow.

A deflector of the kind as disclosed in Mitter is not a flow director as required by the claimed invention.

Significantly, the claimed invention is not directed merely to the deflection of a circulatory flow, but rather the intersection of a circulatory flow by a further flow which is directed towards a printing screen to force pasty product of the circulatory flow onto the printing screen.

Mitter, in providing only for deflection of a flow, whether this be provided by an arcuate surface, such as presented by a circular or tear-shaped deflector, or a planar surface, as presented by one or more shoulders, even if applied to the teaching of Bourrieres *et al* would not achieve a printing head which provides intersecting flows in the manner as required by the claimed invention.

Accordingly, it is submitted that the claimed invention, as claimed in both claims 1 and 12, is clearly distinguished over the disclosures of Bourrieres *et al.* and Mitter.

In rejecting claims 4 to 6, the Examiner is relying on US-5824155 (Ha *et al.*). In this regard, it should be noted that Ha *et al* is the counterpart US patent to WO-96/20088 mentioned in Bourrieres *et al.* (see page 4, line 27 to page 5, line 20), and, as mentioned hereinabove, given that Bourrieres *et al.* is directed to a printing head which is intended to overcome the very problems associated with Ha *et al*, it is inconceivable that a person skilled in the art would have contemplated modifying the teaching of Bourrieres *et al* in accordance with the teaching of Ha *et al.* The fact that a prior art could be modified so as to produce a claimed device is not a basis of an obviousness rejection unless the prior art suggested the desirability of such a modification. In re Gordon, 733 F.2d 900, 221 USPQ 1125 (Fed. Cir. 1984). For that very reason at least, Applicant submits that this ground for rejection does not apply and should be withdrawn.

Formal Request for Interview Under 37 CFR § 1.133

Applicants submit that there is no basis for applying the previous rejections to the pending claims and withdrawal of the rejections is respectfully requested. The claims are

believed to be in condition for allowance, and Applicants earnestly solicit from the Examiner early notification of allowability. Should the Examiner feel that an interview would serve to develop and clarify specific issues in order to advance the prosecution of the application, Applicants respectfully request that the Examiner contact the undersigned to schedule an interview at a mutually convenient time.

Should the Examiner have any other questions, he is also invited to contact the undersigned at his earliest convenience.

Respectfully submitted,

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Appendix B: Marked-Up Version of Substitute Specification

IMPROVEMENTS RELATING TO SCREEN PRINTING

This Application claims priority to International Application PCT/GB00/02781 filed July 19, 2000 and to United Kingdom Application 9916906.2 filed July 19, 1999.

FIELD OF THE INVENTION

The present invention relates to screen printing and particularly to screen printing in which pasty product to be printed is contained within a screen printing head and delivered through the printing head by applied pressure.

BACKGROUND OF THE INVENTION

It is an established technique in the assembly of printed circuit boards to deposit solder paste where connections are to be made with components, place the components on the paste deposits, and then heat the assembly to re-flow the paste and complete the connections. Screen printing machines have been used to deposit solder paste onto printed circuit boards through the apertures of a stencil or screen.

Solder paste consists of metallic microspheres of solder joined by an organic material or flux. The metallic content of such solder paste typically makes up 50 % of the volume, and up to 90 % of the weight of the paste. The viscous flux consists of rheologic agents, adhesive agents and cleaning agents, some of which are thixotropic and others of which are volatile solvents. The thixotropic property of the solder paste has the effect that relative movement of regions within the paste causes a process of shear thinning to locally reduce the viscosity of the paste.

A typical print will comprise a multiplicity of small blocks of solder paste, and for consistent quality it is essential that each block contains the same proportions of each constituent material. This requires a consistent homogeneous distribution of the materials within the solder paste.

In one traditional screen printing technique, as illustrated in Figure 1, an inclined squeegee 1 is used to push a volume of a pasty product 2 over a stencil 3 which includes apertures 4 and is located above a circuit board 5, thereby filling the apertures 4 in the stencil 3 and

providing a deposit on the circuit board 5. Forward movement of the squeegee 1, with a horizontal force F1, causes a downward Force F2 to be applied to the pasty product 2. This downward force F2 forces the pasty product 2 into the apertures 4 in the stencil 3, and in conjunction with the adhesion of the pasty product 2 to the stencil 3 causes the pasty product 2 to roll across the stencil 3 as depicted by arrow 6, thereby shear thinning the pasty product 2.

There are many problems associated with this screen printing technique. One problem is that exposure of the pasty product 2 to the atmosphere results in evaporation of the solvents of the pasty product 2 and hence drying of the pasty product 2. Another problem is that increasing the speed of the squeegee 1 to increase the downward force F2 which forces the pasty product 2 into the apertures 4 of the stencil 3, not only reduces the time available to fill the apertures 4, but can also cause the pasty product 2 to slide across the stencil 3, thereby reducing the rolling effect and hence the shear thinning.

Screen printing heads have been proposed, for example as disclosed in US-A-4622239, which enclose the pasty product to overcome the problems of evaporation, but these printing heads have not addressed the problem of setting a suitable print speed.

WO-A-96/20088 discloses a screen printing head which attempts to overcome both the problems of evaporation and the setting of the print speed by applying a pressure directly to the pasty product. However, this printing head does not provide for a rolling action of the pasty product and hence shear thinning of the same. Furthermore, this printing head requires a very high pressure to be applied to the pasty product. This high pressure can result in the separation of the metallic and flux components of solder pastes which results in inconsistent printing.

WO-A-98/16387 discloses a screen printing head which has been developed partially in response to the known problems of evaporation and the setting of the print speed. As illustrated in Figure 2, this printing head comprises a main body 10, first and second wiper blades 11, 12, which contact a stencil 13 and together with the main body 10 define a chamber 15 containing a pasty product 16, a grille 17 located at the lower end of the main body 10, and a piston 18 for applying a downward force F2 on the pasty product 16. The stencil 13, which includes a plurality of apertures 19, is located above a circuit board 20

onto which deposits of the pasty product 16 are to be printed. In use, the printing head is moved in one of two opposite printing directions, with a horizontal force F1, which causes the wiper blades 11, 12, which are pressed against the stencil 13 by the force imparted on the pasty product 16 by the piston 18, to act to lift the pasty product 16 from the region above the stencil 13 and cause the pasty product 16 to pass upwardly through the grille 17, which pasty product 16 is subsequently forced back downwardly through the grille 17 by the action of the pressure developed by the piston 18. This rolling action of the pasty product 16, as depicted by arrows 21, shear thins the pasty product 16 and thereby enables the pressure F2 applied by the piston 18 to be maintained at a low level and also prevents separation of the components of the pasty product 16 by the mixing effect of the rolling action. Further, the pressure F2 applied to the pasty product 16 is independent of the speed of movement of the printing head.

Whilst this printing head provides for much improved screen printing, it has been established that in some circumstances this printing head does not provide for sufficient shear thinning of the pasty product 16 as necessary for a perfect print.

In the screen printing process, as illustrated in Figure 3a, incomplete filling of the stencil apertures 19 can result where the pasty product 16 is not sufficiently thinned. Where the stencil apertures 19 are incompletely filled, the action of the trailing wiper blade 11 can shear the pasty product 16 over the stencil apertures 19, with the result that the pasty product 16 in the apertures 19 is pushed to one, the forward, end of the apertures 19, as illustrated in Figure 3b, resulting in only a partial print. In an extreme case, the remaining pasty product 16 in the stencil apertures 19 may not be in sufficient contact with the circuit board 20 such that when the circuit board 20 and the stencil 13 are separated, the pasty product 16 is insufficiently adhered to the circuit board 20 and remains in the stencil 13, as shown in Fig 3c, resulting in virtually no print at all. Furthermore, the retention of pasty product 16 in apertures 19 of the stencil 13 can itself lead to problems with subsequent prints since, as mentioned hereinabove, the pasty product 16 is prone to drying out and the drying out of pasty product 16 in the apertures 19 will give rise to printing problems. These problems have been made worse by recent trends in miniaturisation which have led

to the use of smaller stencil apertures 19, which miniaturization reduces the area of pasty product to circuit board contact relative to the area of pasty product to aperture wall contact.

SUMMARY OF THE INVENTION

Accordingly, the present invention provides a screen printing head for applying a pasty product to a printing screen, comprising: a main body; wiper blades disposed to the main body for contacting a printing screen; a first chamber providing a reservoir for containing a supply of pasty product, the first chamber being defined at least in part by the main body and including at least one outlet opening through which pasty product is in use forced under pressure; a second chamber in fluid communication with the at least one outlet opening, the second chamber being defined in part by the main body and the wiper blades and being in use in communication with the printing screen; and a flow director disposed in the second chamber and configured such as in use to cause a circulatory flow of pasty product contained therein which passes over the surface of the printing screen and a flow of pasty product towards the printing screen which acts to force pasty product of the circulatory flow towards the printing screen and into apertures therein.

Such a printing head provides for enhanced shear thinning of the pasty product filled into the apertures of the printing screen and hence improved stencil aperture filling to reduce the incidence of poor quality printing.

Preferably, the at least one outlet opening comprises an elongate slot.

Preferably, the flow director is further configured such as to define first and second circulation zones in which pasty product is locally circulated and through which the circulatory flow is directed.

Preferably, the flow director comprises vanes, with the circulatory flow in use passing beneath lower edges of the vanes.

More preferably, the flow director comprises first and second vanes disposed on opposed sides of the at least one outlet opening, with the lower edges of the vanes defining a nozzle directed towards the printing screen.

Preferably, the nozzle is an elongate nozzle.

Preferably, the main body includes first and second lobe members which in part define the second chamber, the lobe members being disposed above respective ones of the wiper blades and having arcuate lower surfaces to promote the circulatory flow.

In one embodiment the main body includes one or more ports through which the first chamber can be charged with pasty product.

In another embodiment the main body includes a replaceable cassette which defines at least in part the first chamber, the first chamber being charged by replacement of the cassette.

Preferably, the wiper blades comprise flexible wiper blades.

The present invention also extends to a screen printing apparatus comprising the above-described printing head.

The present invention also provides a method of screen printing using a screen printing head including a chamber in communication with the printing screen, comprising the steps of: providing a circulatory flow of pasty product in the chamber which passes over the surface of the printing screen; and providing a flow of pasty product towards the printing screen which acts to force pasty product of the circulatory flow onto the printing screen and into apertures therein.

Preferably, the method further comprises the step of locally circulating pasty product in first and second circulation zones through which the circulatory flow is directed.

BRIEF DESCRIPTION OF THE DRAWINGS

A preferred embodiment of the present invention will now be described herein below by way of example only with reference to the accompanying drawings, in which:

Figure 1 illustrates a sectional view through a squeegee as employed in a traditional screen printing technique;

Figure 2 illustrates a sectional view through a known screen printing head;
Figures 3a, 3b and 3c show the development of defects which can occur during screen printing using the printing head of Figure 2;

Figure 4 illustrates a perspective view of a screen printing head in accordance with a preferred embodiment of the present invention;

Figure 5 illustrates a sectional view through the printing head of Figure 4; and

Figure 6 illustrates a sectional view through the printing head of Figure 4 when in operation.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The screen printing head comprises a main body 30, in this embodiment an elongate body, and first and second inwardly and downwardly directed wiper blades 31, 32 which are clamped to the main body 30 by respective clamping plates and screws. As illustrated in Figures 5 and 6, the wiper blades 31, 32 are in use maintained in contact with a stencil 34, which includes a plurality of apertures 36 and is located above a workpiece 38, in this embodiment a circuit board, onto which deposits of a pasty product are to be printed. In this embodiment the printing head is symmetrically arranged about the longitudinal axis thereof such as to be moveable bi-directionally.

The main body 30 includes first and second lobe members 42, 44, in this embodiment projections, between which an outlet opening 46, in this embodiment an elongate slot, is defined, and first and second chambers 48, 50 in fluid communication through the outlet opening 46. As will be described further herein below, each of first and second lobe members 42, 44 has an arcuate lower, roof surface 52, 54. One, the first, of the chambers 48 provides a reservoir for containing a pasty product 56 and is defined in part by a flexible diaphragm 58 which is in use acted upon to drive pasty product 56 under pressure into the other, second chamber 50. The other, second chamber 50 provides first and second circulation zones 60, [[~~62~~]] 61 in and through which pasty product 56 is circulated as will be described further herein below. In this embodiment the main body 30 includes a plurality of ports [[~~63~~]] 62 for charging the first chamber 48 with pasty product 56. In this

embodiment the second chamber 50 is in use totally enclosed from the atmosphere to prevent drying out of the pasty product 56, with the stencil 34 in part enclosing the second chamber 50.

The printing head further comprises a flow director 63 disposed in the second chamber 50 adjacent the outlet opening 46. The flow director 63 comprises first and second vanes 64, 66 which each extend a distance parallel to the lower surface 52, 54 of respective ones of the first and second lobe members 42, 44 adjacent the outlet opening 46 such as to define passages 67, 68 therebetween and downwardly to define a nozzle 69, in this embodiment an elongate nozzle, therebetween which is spaced rearwardly from the plane defined by the lower edges of the wiper blades 31, 32 such as to allow for a flow of the pasty product 56 therebeneath. With this configuration, the printing head is effectively divided into four sections as defined by the first chamber 48, the first and second circulation zones 60, [[~~62~~]] 61 and the internal space of the flow director 63.

The printing head further comprises sealing members 70 at each of the ends thereof, which sealing members 70 are formed of a flexible material so as to conform to the wiper blades 31, 32 which deflect during printing.

In use, the printing head is brought into contact with the stencil 34 which is located above the underlying workpiece 38. A force F2 is applied to the flexible diaphragm 58 so as to pressurize the pasty product 56 in the first chamber 48 and force the same through the outlet opening 46 into the second chamber 50, the pasty product 56 being forced through the passages 67, 68 and the nozzle 69 into contact with the stencil 34. The printing head is then moved, under a horizontal force F1, across the stencil 34, which movement in conjunction with the adhesion of the pasty product 56 to the stencil 34, causes a circulatory flow of the pasty product 56 in the circulation zones 60, [[~~62~~]] 61 as depicted by arrows 72. Pasty product 56 from the leading circulation zone, in this embodiment the second circulation zone [[~~62~~]] 61, is drawn by adhesion to the stencil 34 between the nozzle 69 and the stencil 34, causing shear thinning of the pasty product 56 in this region. This flow of the pasty product 56 increases the pressure within the trailing circulation zone, in this embodiment the first circulation zone 60, and pasty product 56 is forced back to the leading circulation zone [[~~62~~]] 61 through the passages 67, 68, thereby further shear thinning the pasty product 56. At the same time, the action of the pasty product 56

introduced through the outlet opening 46 into the second chamber 50 is such as to apply a pressure through the nozzle 69 directly to the freshly shear-thinned pasty product 56 in the region below the nozzle 69, forcing the shear-thinned pasty product 56 into apertures 36 in the stencil 34.

The printing head of the present invention provides for better shear thinning than any of the known printing heads, particularly in the critical region between the nozzle 69 and the stencil 34, and provides for much improved packing of pasty product 56 into the stencil apertures 36. The wiper blades 31, 32 are thus able to cleanly cut off the pasty product 56 across the top of the stencil apertures 36, without leaving any voids in the stencil apertures 36. In this way, good contact is established between the pasty product 56 and the workpiece 38 over the full area of the stencil apertures [[~~38~~]] 36, thereby ensuring good separation of the pasty product 56 from the stencil 34 on separating the stencil 34 from the workpiece 38, and as a result high quality printing.

Finally, it will be understood that the present invention has been described in its preferred embodiment and can be modified in many different ways without departing from the scope of the invention as defined by the appended claims. For example, alternative designs for the first chamber 48 are clearly possible, such as an interchangeable cassette system, as disclosed, for example, in WO-A-98/16387. Also, the shape and size of the flow director 63, in particular the nozzle 69, and the first and second chambers 48, 50 can be altered from those of the illustrated embodiment. In particular, the widths of the outlet opening 46 and the nozzle 69, the width and length of the passages 67, 68, and the clearance between the lower edge of the nozzle 69 and the stencil 34, all have an effect on the operation of the printing head and can be altered to provide the desired balance between shear thinning and the maximum feed rate of the pasty product 56.